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PROVISIONAL SPECIFICATION

Invention Title: MAT FOR REDUCING THE DISTURBANCE OF PARTICULATE MATTER BY WIND

Applicant: C GEAR AUSTRALIA PTY LTD

The invention is described in the following statement:

MAT FOR REDUCING THE DISTURBANCE OF PARTICULATE MATTER BY WIND

Field of the Invention

This invention relates to a mat for reducing the disturbance of particulate matter by wind. It relates particularly but not exclusively to a helicopter landing mat suitable for use in areas where there is substantial dust, sand, snow or other particulate matter. The invention will be described with particular reference to the example case of a helicopter landing mat, but it is to be understood that the invention is applicable to the control of dust and other particles in any windy environment, such as on exposed sand dunes, beaches, snow, and dry soil.

Background to the Invention

Dust and other particulate matter can present significant hazards to the operators of rotary wing aircraft. During take-off and landing, and during near-ground hovering, clouds of dust or other particles can be generated around a helicopter. This can result in loss of visibility or "brown-out" in the case of dust or sand, or "white-out" in the case of snow. Particles can clog the air intakes of an aircraft's engines, resulting in overheating, and fine particles ingested through the engines can cause damage and mechanical failures. Coarser airborne particles can cause eye injuries and other types of injuries to people near the aircraft.

Helicopter landing pads are typically constructed from concrete, asphalt, bitumen or another solid surface. When, however, it is necessary to land at a site which does not have a solid landing pad, problems with dust and other particles often arise. One solution has been to create a portable landing pad, and such portable landing pads are typically made from steel or some other strong, and relatively solid and heavy material which is not likely to be blown away by the helicopter's downdraft. However, such landing pads are very cumbersome to move around, and are unsuitable for rapid deployment.

One manner of constructing a short-term helicopter landing pad on a dusty or sandy surface involves spraying the surface with water. The effectiveness of this technique depends on having sufficient water available,

and the landing surface ceases to be usable once the water dries, which may only be a matter of minutes in some environments. A longer term landing pad may be created using sump oil, diesel fuel or another non-volatile liquid, but the effectiveness is still short-lived, it is necessary to have a supply of oil or diesel fuel available, and the environmental damage is significant.

Landing pads are typically not made out of cloth materials such as canvas, because of the dangers associated with the cloth flapping up and getting caught in the helicopter's rotors. Even if a canvas tarpaulin were firmly anchored down on every side, there is still the possibility that in a heavy landing a helicopter's skids might tear the canvas, and the helicopter's downdraft on the torn portion of the canvas would cause air to flow under the canvas, lifting the canvas and accentuating the tear, with the attendant risk that a torn portion of the canvas will be caught up in the helicopter's rotors.

In some military operations, landing mats are made of aluminium sheet (which may be fabric-like, rather than rigid metal). Aluminium is less hazardous than canvas, but there are significant difficulties and dangers experienced with wind getting under the mats, or blowing the mats or pieces of mat around, resulting in injury to people on the ground as well as endangering the helicopter

A further problem associated with the use of a flexible landing pad arises from the effect of the helicopter's downdraft on the edges of the landing pad. As the helicopter's downdraft nears the ground, it is directed outwardly, so that the air flow near the edges of the landing pad is rapid and nearly horizontal. The rapidly flowing air on the top side of the landing pad has a lower pressure than the still air on the underside of the landing pad, and this causes the edges of the landing pad to flap up. In the past, this problem has been dealt with by making the edges of the landing pad so heavy that they cannot be moved by the airflow, but this significantly reduces the portability of the landing pad.

Summary of the Invention

According to a first aspect of the present invention, there is provided a mat for reducing the disturbance of particulate matter by wind, the mat including:

(a) a first layer of coarse mesh material; and

(b) a second layer of coarse mesh material;

wherein the first layer is held in a substantially fixed position relative to the second layer.

It has been found that a mat with two or more layers of coarse mesh material can be effective in preventing the majority of the particulate matter under the mat from escaping, while at the same time allowing some of the wind to pass through the mat. This reduces the pressure differentials between the top and bottom sides of the mat, making the mat much more likely to resist tears and endure strong winds than a comparable mat made from non-porous cloths such as canvas.

The mesh material may be any suitable type of material. It is preferred that the mesh material is a knitted material with average stitch length of between 2 mm and 6 mm, and the average separation between the first and second layer is between 2 mm and 10 mm.

The mesh material may be formed from any suitable type of fibres. Natural fibres such as wool and cotton can be used, but it has been found that particularly desirable results are achieved if the mesh material is formed from plastics fibres.

The porosity of the mesh material, or the proportion of the surface area of the mesh which consists of holes rather than fibres, may have any suitable value. It is preferred that each layer of the mesh material has a porosity of between 10% and 50%.

Wind which strikes the mat will partly pass through the mat and partly be stopped by the mat, so that the windspeed on the downwind side of the mat will be attenuated relative to the windspeed on the upwind side. It is preferred that each layer of the mesh material has a wind attenuation factor of between 40% and 80% for wind directed at right angles onto the mesh material at 50km/h.

According to another aspect of the invention, there is provided a helicopter landing mat, which includes one or more mats of the type previously defined. The helicopter landing mat further includes a peripheral region which has a greater mass per unit area than the mesh material, and the first layer is attached to the second layer in the peripheral region.

Preferably, the helicopter landing mat has a length and a width which exceed the rotor span of a helicopter.

According to a second aspect of the invention, there is provided a method of reducing the disturbance of particulate matter on a surface by wind, including the steps of:

(a) covering the surface with a mat which has a first layer of coarse mesh material and a second layer of coarse mesh material, the first layer being held in a substantially fixed position relative to the second layer; and

(b) fixing the mat to the surface at a plurality of points around the periphery of the mat.

Brief Description of the Drawings

The invention will now be described in further detail by reference to the attached drawings which show example forms of the invention. It is to be understood that the particularity of those drawings does not supersede the generality of the preceding description of the invention.

Figure 1 shows two layers of knitted mesh material in a cut-away corner section of a mat according to an embodiment of the invention.

Figure 2 shows a sample of knitted mesh material suitable for use in an embodiment of the invention.

Figure 3 shows an extendible arrangement of a plurality of mats joined together to form a helicopter landing mat.

Figures 4a to 4d show the results of experimentation using a simulation of a helicopter downdraft on mats covering sand.

Detailed Description

Referring firstly to Figure 1, there is shown a cut-away corner section of a mat for reducing the disturbance of particulate matter by wind, according to an embodiment of the invention. The mat includes a first layer of coarse mesh material and a second layer of coarse mesh material. The first layer is held in a substantially fixed position relative to the second layer. Reinforcing material is provided along the edges, although tests have shown that such reinforcing is not essential.

Figure 2 provides further detail of a suitable type of mesh material. A preferred type of mesh material is a knitted material with average stitch length of between 2 mm and 6 mm. In the embodiment illustrated, the average stitch

length is around 3 mm. The desirable mesh size depends to some extent on the size of the particles, with a finer mesh size being appropriate for finer particles. Knitted material is preferred over woven material because it is less prone to failure if one stitch is torn, and also because it typically allows more appropriately sized and shaped holes.

The average separation between the first layer and the second layer is preferably between 2 mm and 10 mm, so that the mat essentially forms a three-dimensional mesh. The mat may include a third and possibly further layers, but there is a trade-off between the desirable characteristics of letting wind pass through from top layer to bottom layer on the one hand, and stopping particulate matter from underneath the mat passing through the layers on the other. The presence of too many layers increases the wind attenuation factor to a figure which is too high for the mesh to function effectively.

The mesh material may be made from cotton or another natural fibre, but in preferred arrangements the mesh material is formed from plastics fibres. Smooth plastics fibres are typically smoother than natural fibres and therefore provide a lower degree of wind resistance, so that the wind attenuation factor is lower.

It is not uncommon for fuel or oil or hydraulic fluid to be spilled on the ground surrounding a helicopter. Accordingly, it is preferred that the mats are made from materials at least somewhat resistant to fuel spills, oil, hydraulic fluid, water and other types of staining and contamination. Further, because of the high temperatures generated around parts of helicopters, flame resistance and /or flame retardant properties are also very desirable.

It is also desirable that mats according to the invention be resistant to the build-up of static electricity. One way of avoiding static electricity involves electrically grounding the mats, such as by means of metal pegs securing the mats to the ground and/or a metal wire traversing the mats.

A mat according to the invention may be any suitable colour. In one preferred arrangement, the colour of the mat is similar to the surrounding terrain, for example a sandy colour for desert situations and green for grassed areas. In another arrangement, the mat is of a contrasting colour to the terrain, so that it can easily be spotted from the air. In another arrangement, a mat is one colour on one side and a different colour on the other side.

The porosity of the mesh material, or the proportion of the surface area of the mesh which consists of holes rather than fibres, is preferably between 10% and 50%. In the embodiment illustrated in Figure 2, the porosity is around 30%.

The overall wind attenuation factor of the mat will depend on a number of factors, including the smoothness of the fibres used, the size of individual holes (which is related to the stitch length in knitted materials), and the porosity of each layer of the mesh material. The layers may have different wind attenuation factors, but it is preferred that each layer of the mesh material has a wind attenuation factor of between 40% and 80% for wind directed at right angles onto the mesh material at 50km/h.

The mat of the present invention is suitable for use in numerous different situations to reduce the undesirable effects of dust or other airborne particles. The mat may be used for a helicopter landing mat on dusty ground, sandy ground, or snow, as discussed previously. It may also be used for dust or airborne particle control in large ground expanses such as military camps, refugee camps, outdoor venues (concerts, sporting events, etc), animal enclosures and other situations where dry dusty conditions prevail (especially in droughts).

Because of the degree of wind porosity of mats according to the invention, it is not in all cases essential that the mat be secured to the ground. In tests conducted with a mat on a concrete surface subjected to a simulated helicopter downdraft, there was no flapping around the edges even though the mat was not secured to the ground, and even though the edges of the mat were not made heavier through reinforcing. It will still in most cases be desirable that the mat be fixed to the ground around its periphery, but the degree of securing can in many cases be fairly minimal.

Figure 3 illustrates a helicopter landing mat, in which a plurality of different mats have been joined together to form one composite mat. Each individual mat in this arrangement includes a peripheral region which has a greater mass per unit area than the mesh material, and the two layers of the mesh material are joined to each other in the peripheral region. Adjoining mats may be secured together in any suitable manner. Suitable securing means include lacing or tying the mats together with rope or wire, hook-and-loop

fastening, metal or plastic clips or ties, or tent pegs (which may be flat-topped to minimise protrusions that may interfere with landing helicopters). Desirably, any overlapping edges of adjoining mats (for example when joined by hook-and-loop fastening) are arranged so that the edge of the mat nearest to the centre of the helicopter landing pad overlaps on top of the adjoining mat, so that the downwash moving from the centre of the landing pad towards the edges presses down on the joins.

The helicopter landing mat has a length and a width which exceed the rotor span of a helicopter, ideally by a significant amount, reducing the likelihood of particulate matter surrounding the mat being caught up into a dust cloud. In the example shown in Figure 3, the composite mat is 21 metres by 21 metres in size, and it is composed of seven smaller mats, one of which is 7 metres by 7 metres, the other six each being about 3.5 metres by 14 metres in size. The edging of each mat may be reinforced to allow for the mats to be pulled tight and pegged to the ground, although tests have demonstrated that reinforcing is not essential. Each mat is portable and weighs around 20 to 22 kg, so the total weight is around 190 kg. When the mats are folded, they occupy a total volume of approximately 1 cubic metre. Each mat can be stored in its own bag, which can comfortably be lifted by one or two men. All the mats can be stored in a single carry bag for storage and transit to keep the set together. Alternatively, mats can be folded and/or rolled before being secured by straps and buckles for storage and transportation.

The mats have great tensile strength, and are laid directly on the ground. The central landing mat may be additionally reinforced. The matting can be laid by two people in less than 30 minutes, and packed away by two people in less than an hour. This compares with a set-up time of a few days for previous "portable" helicopter landing pads.

The sizes and configuration of the mats shown in Figure 3 are illustrative only. A variety of sizes and configurations can be used depending upon specific situations and requirements. A mat according to the present invention may be as small as 1m x 1m or as large as 60m x 60m, for example. For larger military helicopters such as 'Black Hawks', an overall configuration of around 40 to 50m x 40 to 50m is desirable, with heavy duty centre landing pad(s) of 12m x 12m. In other configurations, all mats making up a landing pad may be of substantially

the same size and weight, without any special reinforcing on the centre mat, so that all mats are interchangeable and the respective positions of the mats may be rotated so that the amount of wear on the mats is even. Mats sustaining damage may be swapped with undamaged mats.

In some applications, a square overall configuration of the landing pad is appropriate; in other configurations, the mats may be arranged in a rectangular shape or any other suitable shape.

Although the mats illustrated in Figure 3 are fixed to the ground by means of pegs, numerous other ways of securing the mats may be used. In sandy and/or dry loose dirt, sandbags, water bladders and other means may be adopted to secure the mats (typically they would already have been tied together) to the ground.

Test Data

Tests were conducted on a sample mat according to an embodiment of the invention. The aim of the testing was to determine the efficiency of the mat in containing particles whilst being subjected to wind velocities comparable with those expected on the ground beneath a military helicopter.

The velocity of the rotor wake of a helicopter depends on the disc loading of the helicopter. Disc loading is the rotor disc area (πR^2) divided by the gross weight of the helicopter. As a general rule, the downwash of the helicopter increases with the size of the helicopter. For a Sikorsky S-76C helicopter at maximum gross weight of 5,320 kg, the disc loading is 37.6 kg/m^2. This gives rise to a downwash velocity at the rotor plane of around 45km/h. As the flow descends below the helicopter, it accelerates, reaching a maximum speed of about twice the velocity at the rotor plane, or about 90km/h, at a distance of approximately one rotor diameter below the rotor. The test therefore aimed to reach or exceed this wind velocity.

Particles were pre-weighed and then evenly distributed over an area of 1.4 x 1.7 meters. This was then covered by the mat which was taped in place. The mat was then subjected to a wind blast for 60 seconds from a height of 80 cm by an air blast machine delivering a rated wind velocity of 145 mph. The mat was then carefully removed and the particulate matter recovered and

weighed to determine the amount of matter that has been displaced from beneath the matting.

As a control measure and for comparative assessment, the test was repeated without the mat. The testing was conducted for both fine and coarse particulate matter. Common flour was used as the fine particles and beach sand was used for the coarse particles.

The test results are presented in the tables below:

and Test	Qty Grams
Start quantity	1128.00
After Blow	1103.00
Loss of Sand	25.00
Percentage Loss	2.22%
Sand Control Test - No Mat	
Start quantity	1128.00
After Blow	231.00
Loss of Sand	897.00
Percentage Loss	79.52%
Relative Efficiency	**97.21%**

Dust Test	Qty Grams
Start quantity	282.00
After Blow	248.00
Loss of Dust	34.00
Percentage Loss	12.06%
Dust Control Test - No Mat	
Start quantity	282.00
After Blow	45.00
Loss of Dust	237.00
Percentage Loss	84.04%
Relative Efficiency	**85.65%**

Figures 4a to 4d illustrate the manner in which the tests were conducted. The results of the test appear to indicate that the mat is effective in reducing the

incidence of both airborne sand and airborne dust, with the matting being more effective in reducing the incidence of airborne sand.

It is to be understood that various alterations, additions and/or modifications may be made to the parts previously described without departing from the ambit of the invention.

The claims defining the invention are as follows:

1. A mat for reducing the disturbance of particulate matter by wind, the mat including:

(a) a first layer of coarse mesh material; and

(b) a second layer of coarse mesh material;

wherein the first layer is held in a substantially fixed position relative to the second layer.

2. A mat according to claim 1 wherein the mesh material is a knitted material with average stitch length of between 2 mm and 6 mm, and the average separation between the first and second layer is between 2 mm and 10 mm.

3. A mat according to claim 1 or claim 2 wherein the mesh material is formed from plastics fibres.

4. A mat according to any one of claims 1 to 3 wherein each layer of the mesh material has a porosity of between 10% and 50%.

5. A mat according to any one of claims 1 to 4 wherein each layer of the mesh material has a wind attenuation factor of between 40% and 80% for wind directed at right angles onto the mesh material at 50km/h.

6. A helicopter landing mat, including one or more mats according to any one of claims 1 to 5, further including a peripheral region which has a greater mass per unit area than the mesh material, wherein the first layer is attached to the second layer in the peripheral region.

7. A helicopter landing mat according to claim 6, wherein the mat has a length and a width which exceed the rotor span of a helicopter.

8. A helicopter landing mat substantially as herein described with reference to the drawings.

9. A method of reducing the disturbance of particulate matter on a surface by wind, including the steps of:

(a) covering the surface with a mat which has a first layer of coarse mesh material and a second layer of coarse mesh material, the first layer being held in a substantially fixed position relative to the second layer; and

(b) fixing the mat to the surface at a plurality of points around the periphery of the mat.

10. A method of reducing the disturbance of particulate matter on a surface by wind according to claim 9, wherein each layer of the mesh material is a knitted material made from plastics fibres with average stitch length of between 2 mm and 6 mm, and the average separation between the first and second layer is between 2 mm and 10 mm, and each layer of the mesh material has a porosity of between 10% and 50% and a wind attenuation factor of between 40% and 80% for wind directed at right angles onto the mesh material at 50km/h.

DATED : 5 November, 2003

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David B Fitzpatrick

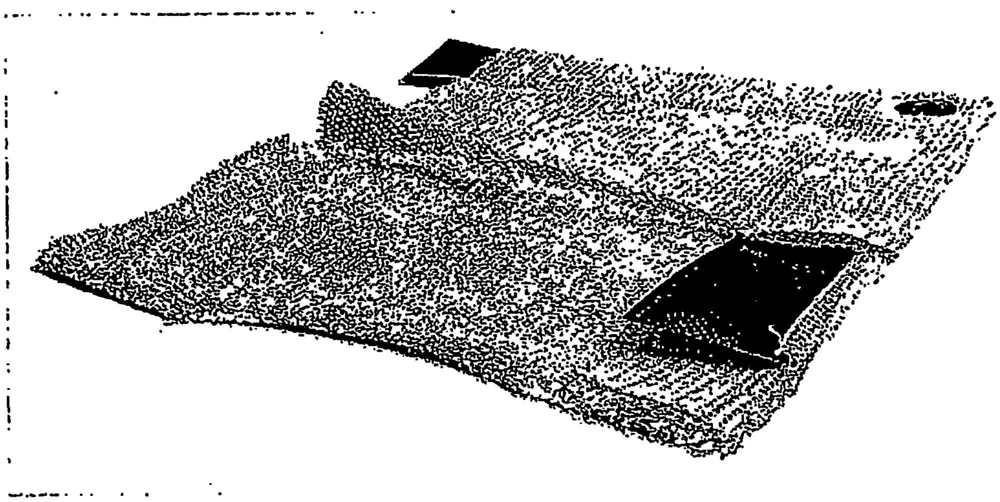


Figure 1

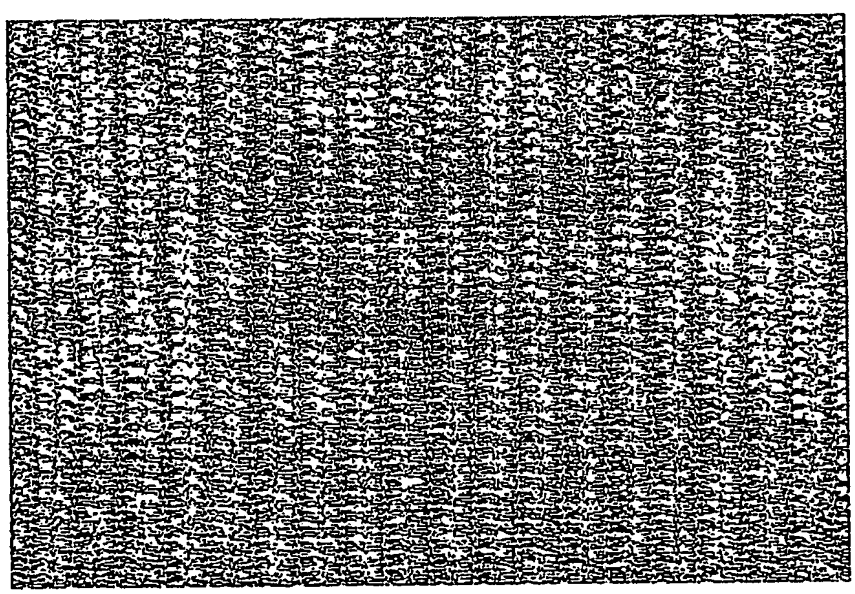


Figure 2

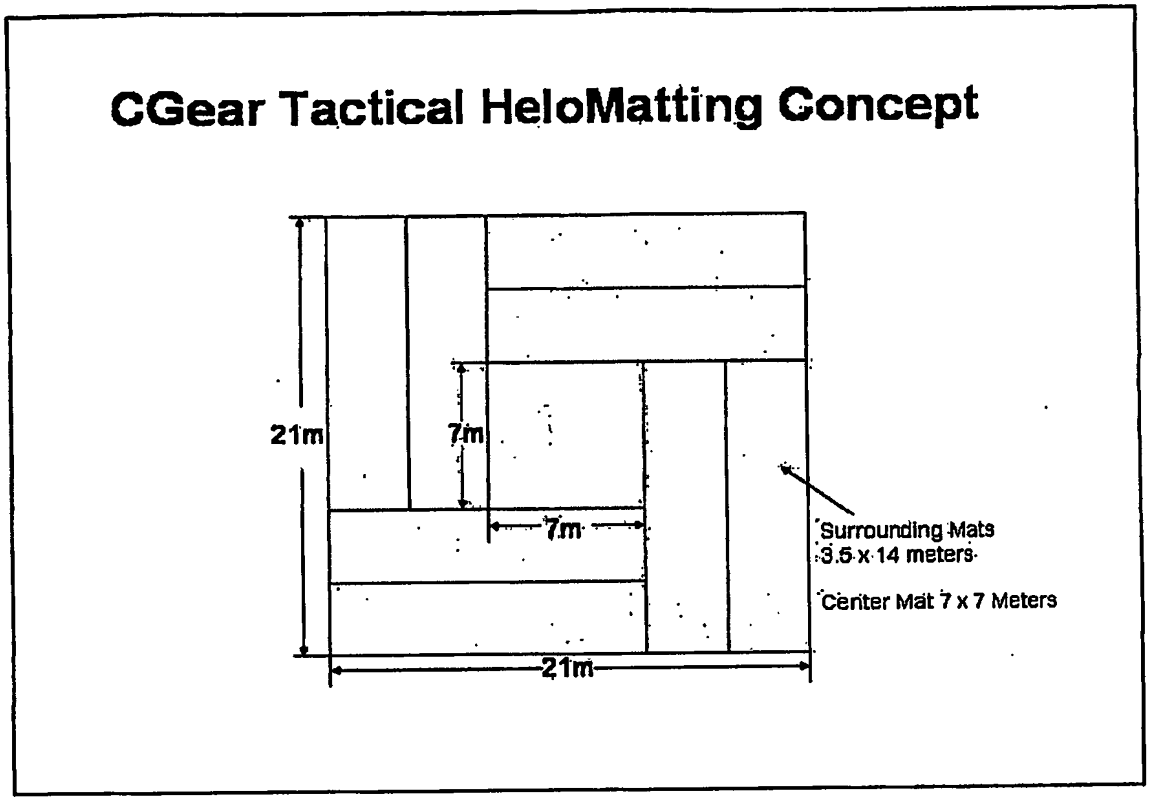
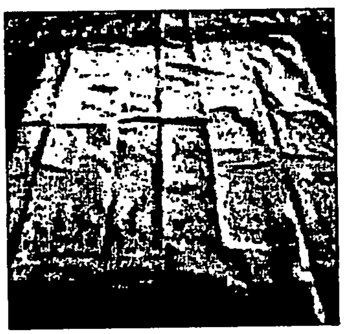

CGear Tactical HeloMatting Concept
21m
7m
7m
21m
Surrounding Mats
3.5 x 14 meters
Center Mat 7 x 7 Meters

Figure 3

Test Methodology

Figure 4a



Sand Distribution Prior To Test

Figure 4b

Sand Distribution After Test

Figure 4c

Sand Distribution After Control (no mat) Test

Figure 4d

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